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AUTHOR Richardson, Kathy
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ABSTRACT

The National Council of Teachers of Mathematics recently published "Principles and Standards for School Mathematics." For the first time, these new standards include pre-kindergarten standards, while outlining the mathematics that children should learn as they progress through school. The standards present a broad view of what mathematics is and can be for young children--a view that early childhood educators implementing developmentally appropriate practices can use. This digest discusses the latest mathematics standards for young children and how teachers can use developmentally appropriate practices to help children meet these standards. The digest points out that "Principles and Standards for School Mathematics" identifies both content and process standards. The content standards are organized into several areas: (1) number and operations; (2) geometry; (3) measurement; (4) data analysis and probability; and (5) algebra. The process standards set out in "Principles" are congruent with developmentally appropriate practice and include the following: (1) problem solving; (2) reasoning and proof; (3) communication; (4) connections; and (5) representation. Teachers' questioning techniques--including those intended to help children understand concepts, hypothesize, and generate interesting questions--can help children appreciate the mathematics that surrounds them. The digest cautions that in our eagerness to help children meet the standards, we must take care not to use instructional methods that give the appearance of high math achievement but that, in fact, interfere with real growth in understanding. The digest concludes by noting that the most effective way to meet standards is to work toward them by beginning wherever the child is--any other strategy simply wastes the child's time and prevents the development of the essential foundational understandings and skills needed for future success. (LPP)

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ERIC Clearinghouse on Elementary and Early Childhood Education

University of Illinois • 51 Gerty Drive • Champaign, IL 61820-7469
(217) 333-1386 • (800) 583-4135 (voice/TTY) • ericeece@uiuc.edu • http://ericeece.org

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Mathematics Standards for Pre-Kindergarten through Grade 2

Kathy Richardson

Concern about the mathematics achievement of America's youth has reached a new level. It is clear in this increasingly technological and global society that achievement in mathematics will have a major impact on students' "career aspirations, their role in society, and even their sense of personal fulfillment" (Malcom, 1999). This high level of concern has resulted in a growing appreciation for the impact that early mathematics learning could have on the life course of young children. Traditionally, mathematics has received little attention in preschools and in many K-2 classrooms (Johnson, 1999). This situation is changing as mathematics learning is recognized as critical to school success.

The National Council of Teachers of Mathematics (NCTM, 2000) recently published *Principles and Standards for School Mathematics*, building on its 1989 *Curriculum and Evaluation Standards for School Mathematics*. The current version includes pre-kindergarten standards for the first time and outlines the mathematics that children should learn as they progress through school. While some observers question the appropriateness of any standards for this age group, other critics argue that the current standards may be less developmentally appropriate than the previous standards, moving in the direction of content knowledge and product orientation. This Digest discusses the latest mathematics standards for young children and how teachers can use developmentally appropriate practices to help children meet these standards.

What Mathematics Should Pre-K through Grade 2 Students Be Learning?

Many early childhood educators approach teaching mathematics with feelings of anxiety. However, the mathematics presented in *Principles and Standards for School Mathematics* provides a broad view of what mathematics is and can be for young children—a view that early childhood educators implementing developmentally appropriate practices can use. Mathematics can provide children with ways to understand and appreciate the world around them and enrich rather than narrow children's experiences. *Principles and Standards for School Mathematics* identifies both content and process standards.

Content Standards. The content standards are organized into several areas: (1) number and operations, (2) geometry, (3) measurement, (4) data analysis and probability, and (5) algebra. Mathematics in the early years is not just a simpler version of mathematics that children will learn later. Rather, teaching about mathematics in early childhood classrooms provides foundational concepts that are key to understanding more formal and abstract ideas. To be truly prepared for later math, young children need to develop flexibility in thinking about numbers (NCTM, 2000). For example, they need to know that 5 is 1 more than 4 and 2 less than 7. They need to know that 5 objects can be arranged in different ways: as 3 and 2 or 4 and 1, and also as 2 and 2 and 1. They need to be able to solve problems by using relationships such as 3 + 3 = 6, so 3 + 4 must be 7 (Richardson, 1999a; Althouse, 1994).

To understand measurement, children first need to be aware of what can be measured. They need to line things up, to cover spaces with blocks that fit together, and to pour sand or water from one container to another. If children are going to understand geometric principles, they first must put together blocks to make new shapes and to recognize the difference between a triangle and a rectangle. In short, children need to experience the applications of mathematics in their everyday lives.

Process Standards. As stated in *Principles and Standards for School Mathematics*, "Learning with understanding is essential to enable students to solve the new kinds of problems they will inevitably face in the future" (NCTM, 2000, p. 21).

The process standards set out in *Principles* are congruent with developmentally appropriate practice and include (1) problem solving, (2) reasoning and proof, (3) communication, (4) connections, and (5) representation. The standards suggest that young children should be encouraged to solve problems, investigate, and use mathematics to find out things they don't already know. Children can be encouraged to reason, to conjecture about the way things are, and to check those conjectures. The emphasis is on children thinking for themselves, rather than repeating what the teacher wants. Children will want to communicate, listen, and clarify their own thinking in the process of communicating with others.

What Questioning Techniques Can Teachers Use?

Teachers' questioning techniques—including those intended to help children understand concepts, hypothesize, and generate interesting questions—can help children appreciate the mathematics that surrounds them.

Number and Operations: Rather than engaging in rote counting and numeral recognition, children can be encouraged to ask: How many are there? Can we find out without counting them all? How many do we need? Do we have enough? Who has the most? Are there any extras? What happens when we take numbers apart or put them together?

Geometry: Rather than simply learning the names of basic shapes, children can discover: How are these shapes alike? How are they different? Which ones fit together? Which ones leave spaces? What can we build with these? What other shapes can we make using these shapes?

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Measurement: Rather than learning how to use a ruler, children can determine: Which is bigger? More? Heavier? Longer? Shorter? How can we find out?

Data Collection: Children can prepare to represent data in charts and graphs by sorting and organizing objects into groups to find out which group has more or less. "Do we have more red apples or more green apples?"

Algebra: Rather than using symbols to stand for various amounts, children can work with ideas related to generalization and predictability through the exploration of patterns. What comes next? How do you know?

Mathematics also helps children understand, organize, and analyze their science experiences. They can experience the connections between math and music when exploring rhythm and patterns, and between math and art when working with symmetry and design.

How Can We Help All Children Meet the Standards?

Research suggests that children's math concepts are often more sophisticated than traditionally assumed (Gelman, 1999). However, in our eagerness to help children meet the standards, we must take care not to use instructional methods that give the appearance of high math achievement but that, in fact, interfere with real growth in understanding. Children are much more capable and confident when they are allowed to make sense of things instead of trying to follow someone else's thinking. Elkind (1999) reminds us that, as we seek to determine what is possible for children, "the only way to understand how children learn a concept is to observe them in the process of acquiring it."

Teachers, parents, and administrators will want to keep in mind that meeting the standards is a long process. For example, one state lists in its Math Checklist for Kindergarten, "Identify, name, and draw a circle, rectangle, triangle, hexagon, rhombus, trapezoid, and square" (Arkansas, 2000). Before children can meet this standard with understanding, they must be able to recognize a variety of triangle shapes and distinguish these from a variety of hexagon shapes. They must be able to draw straight and diagonal lines of similar lengths and connect them appropriately. In that same checklist is the standard "Counts and keeps track of up to 20 objects." Even this seemingly straightforward skill is highly complex and understood in different ways as children develop competence over time (Richardson, 1997b, 1999a). Clearly, early childhood educators will need to continue to explore ways to individualize the mathematics curriculum for all children.

Conclusion

The most effective way to meet standards is to work toward them by beginning wherever the child is. Any other strategy simply wastes the child's time and prevents the development of the essential foundational understandings and skills needed for future success. It is important to be in tune with both the accomplishments and the still undeveloped ideas that are a part of the child's growing understanding. It is exciting and even inspiring to think that we can provide more mathematics for children than we may have done in the past. We do not have to fear raised expectations as long as we look first to the child with respect for wherever he or she is on the journey toward deeper understanding of mathematics.

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